

# Haber Process

# ammonia

| Stage of process   |  |
|--|--|
| Raw materials  | <ul style="list-style-type: none"> <li>Nitrogen from the air</li> <li>Hydrogen from methane CH<sub>4</sub></li> </ul>  |
| Catalysed equation<br><b>Iron Oxide catalyst for Haber Process.</b>                                  | <ul style="list-style-type: none"> <li><math>\text{N}_{2(g)} + 3\text{H}_{2(g)} \rightleftharpoons 2\text{NH}_{3(g)}</math></li> <li>Physical conditions required: high pressure 200-1000 atm and high temperature 400°C</li> </ul>  |
| Process to convert raw materials into reactants<br><br>[Catalyst in first reaction is nickel oxide.] | <ul style="list-style-type: none"> <li>Methane and steam react to produce hydrogen gas<br/><math>\text{CH}_{4(g)} + \text{H}_2\text{O}_{(g)} \rightarrow \text{CO}_{(g)} + 3\text{H}_{2(g)}</math></li> <li>Air converts some hydrogen to steam<br/><math>4\text{N}_{2(g)} + \text{O}_{2(g)} + 2\text{H}_{2(g)} \rightarrow 2\text{H}_2\text{O}_{(g)} + 4\text{N}_{2(g)}</math></li> <li>Carbon monoxide is oxidized by steam to make CO<sub>2(g)</sub><br/><math>\text{CO}_{(g)} + \text{H}_2\text{O}_{(g)} \rightarrow \text{CO}_{2(g)} + \text{H}_{2(g)}</math></li> </ul> <p>Potassium carbonate solution is used to scrub the CO<sub>2(g)</sub> - removal of CO<sub>2</sub> - so it minimizes environmental impact.</p> |
| Getting product – NH <sub>3(g)</sub>   | <ul style="list-style-type: none"> <li>Ammonia is liquefied (liquefaction) or dissolved in water<br/><math>\text{NH}_{3(g)} + \text{H}_2\text{O}_{(l)} \rightarrow \text{NH}_4\text{OH}_{(aq)}</math></li> </ul>   |
| NH <sub>3(g)</sub> is used for...  | <ul style="list-style-type: none"> <li>To make fertilizers</li> <li>To make nitric acid</li> <li>To make nylon</li> </ul>  |

